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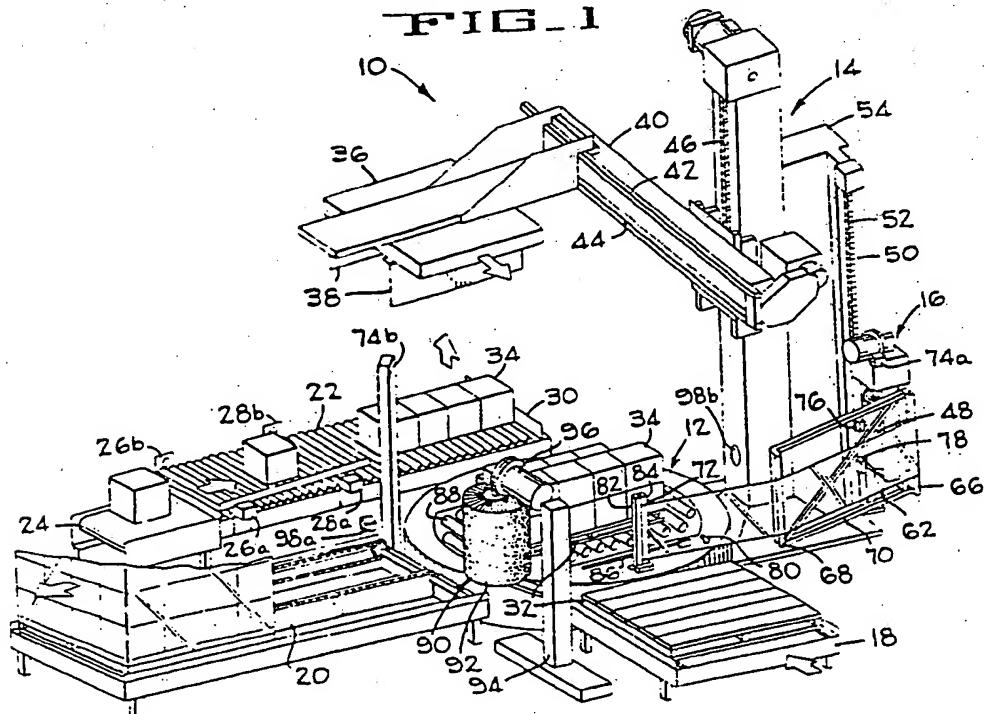
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(54) Load unitizer

(57) An article unifying device is provided to stack and wrap a plurality of articles 34 on a turntable 12. While the articles are being stacked on the turntable by a palletiser 10, wrapping web 62 is e.g. stretched-wrapped around the stack of articles at intervals during the stacking process and at the completion of the stack by rotation of the turntable.

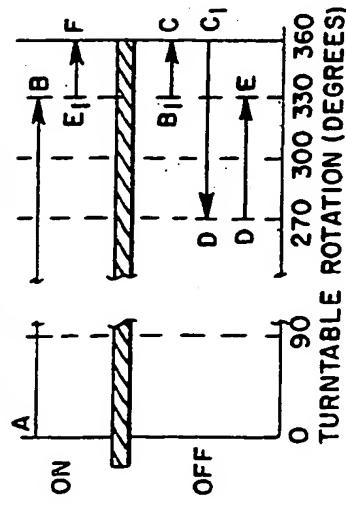
FIG. 1



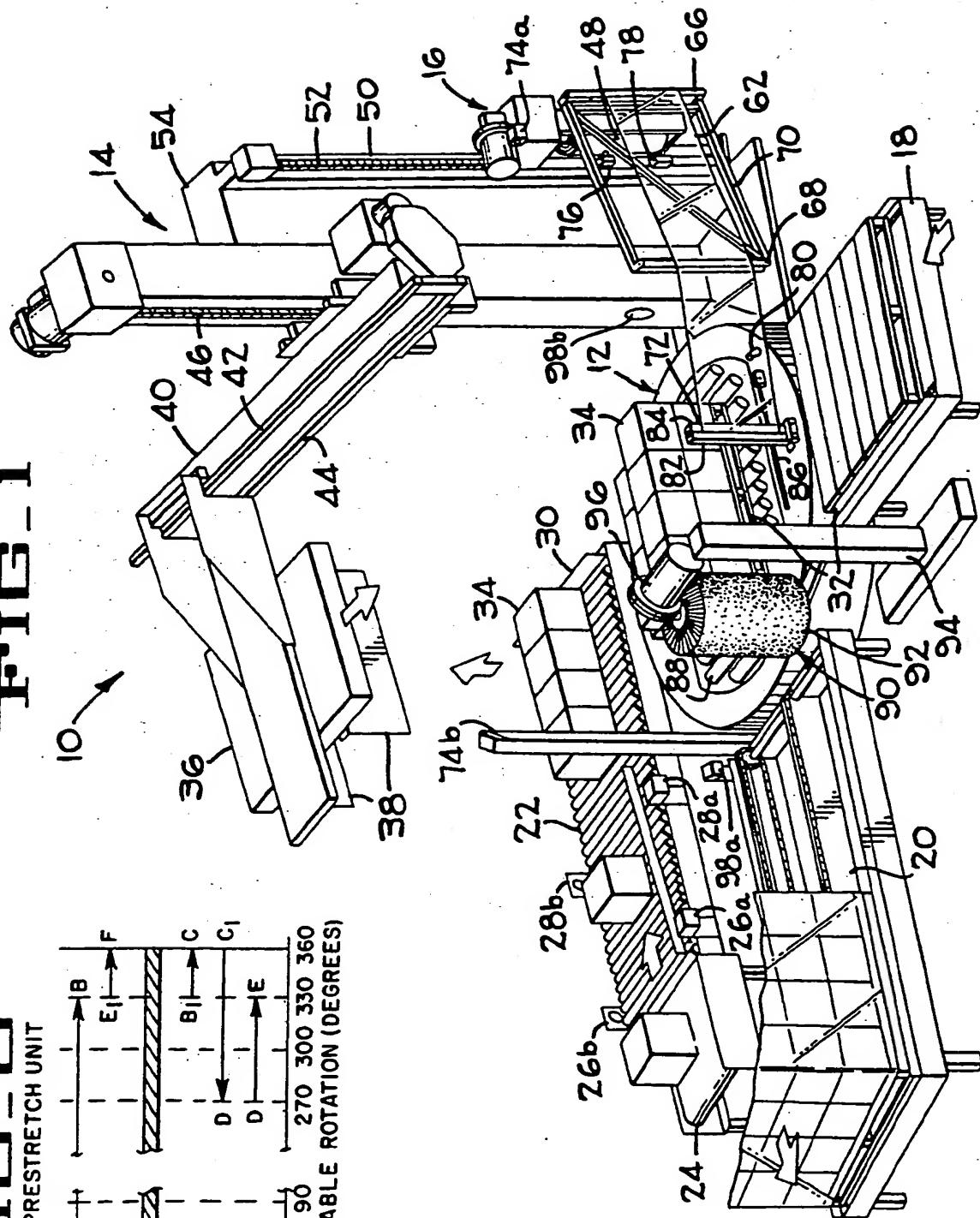
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# FIG-6

FILM PRESTRETCH UNIT



# FIG-1

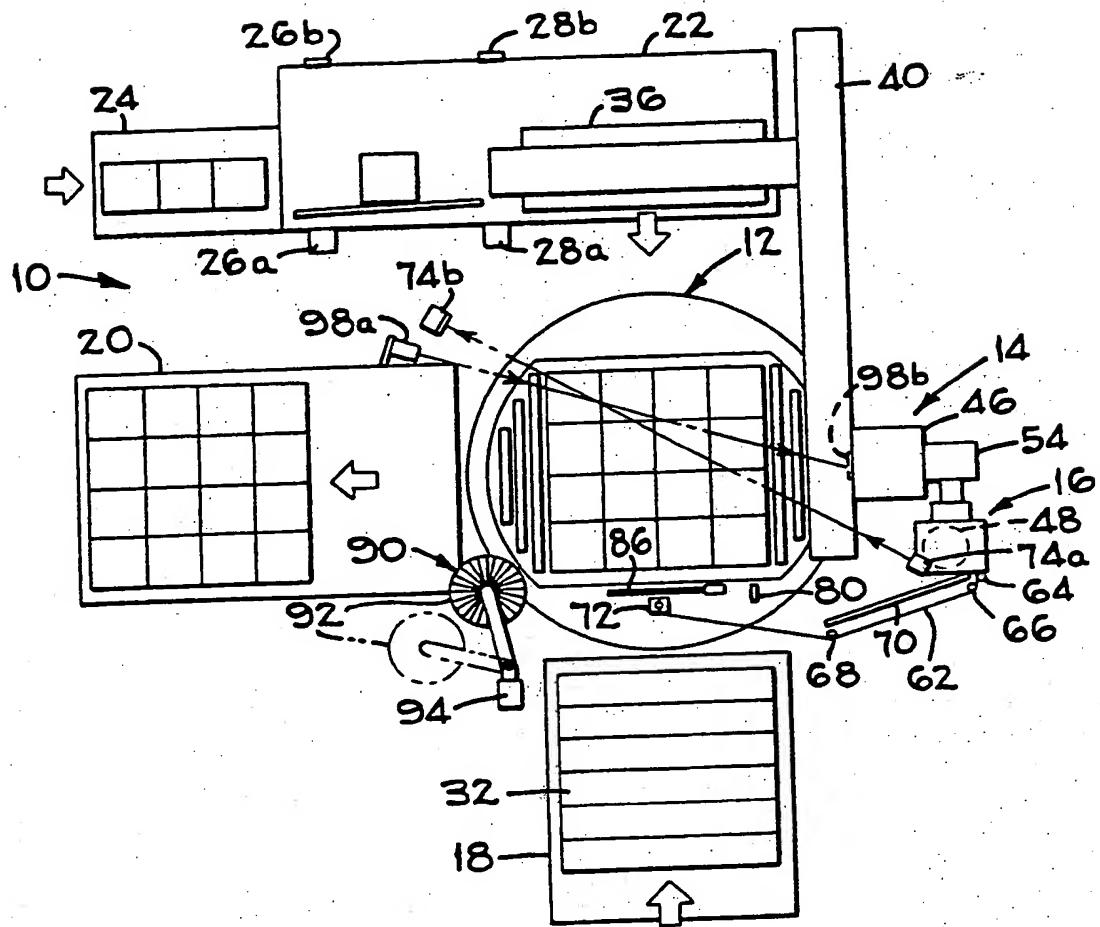
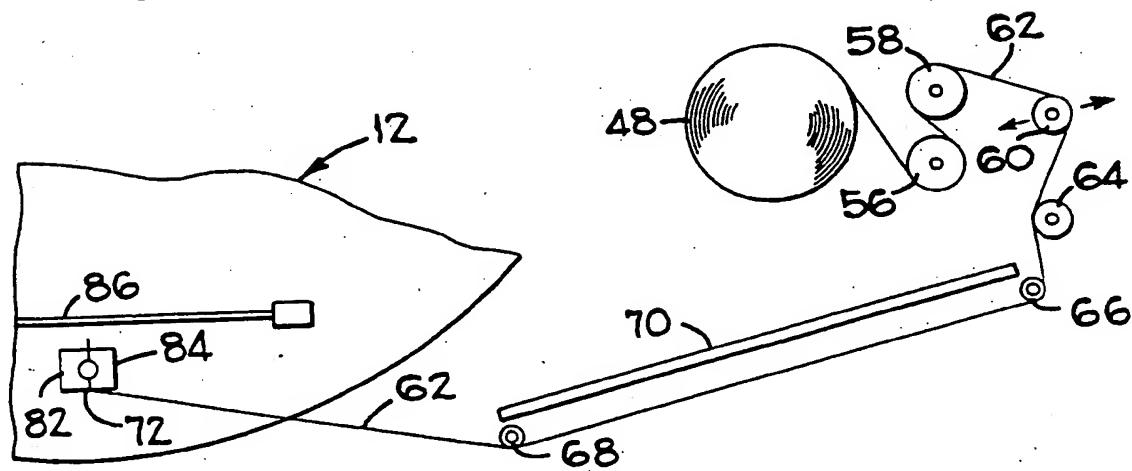


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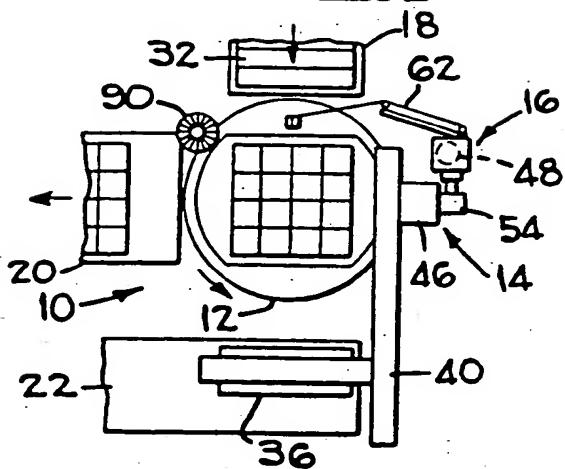
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**FIG. 2****FIG. 3**

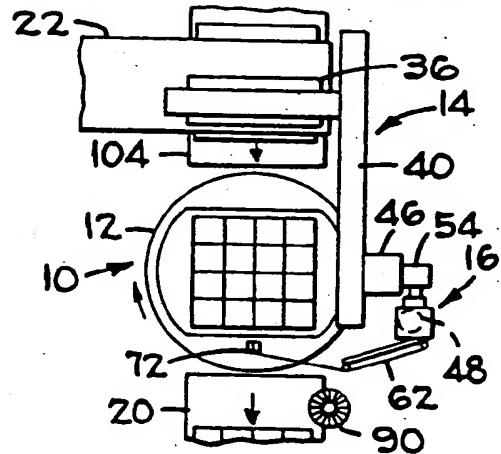
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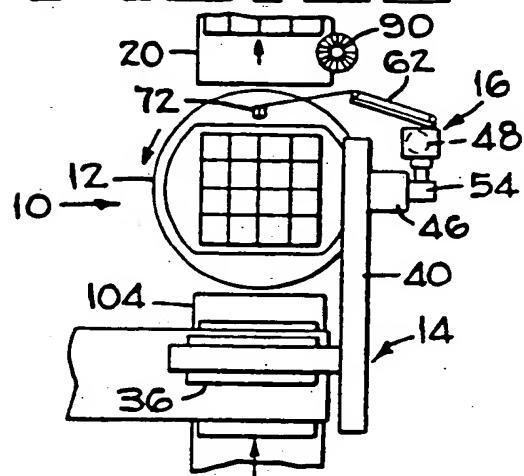
**FIG. 2A**



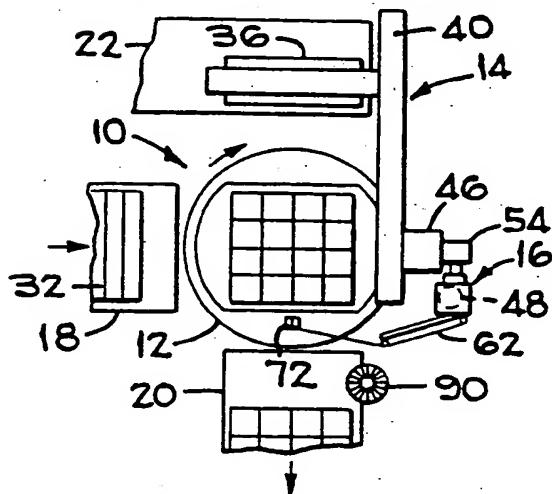
**FIG. 2B**



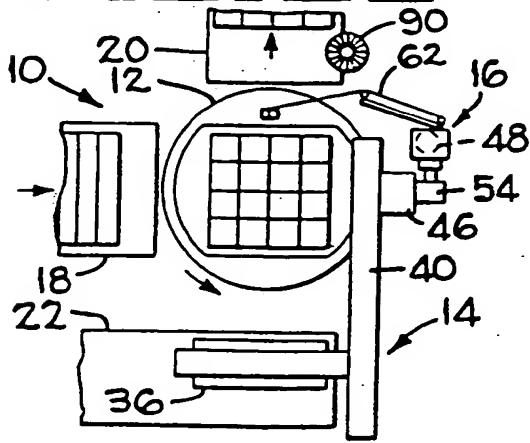
**FIG. 2C**



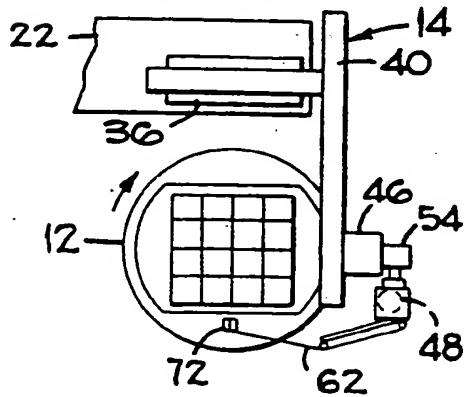
**FIG. 2D**



**FIG. 2E**



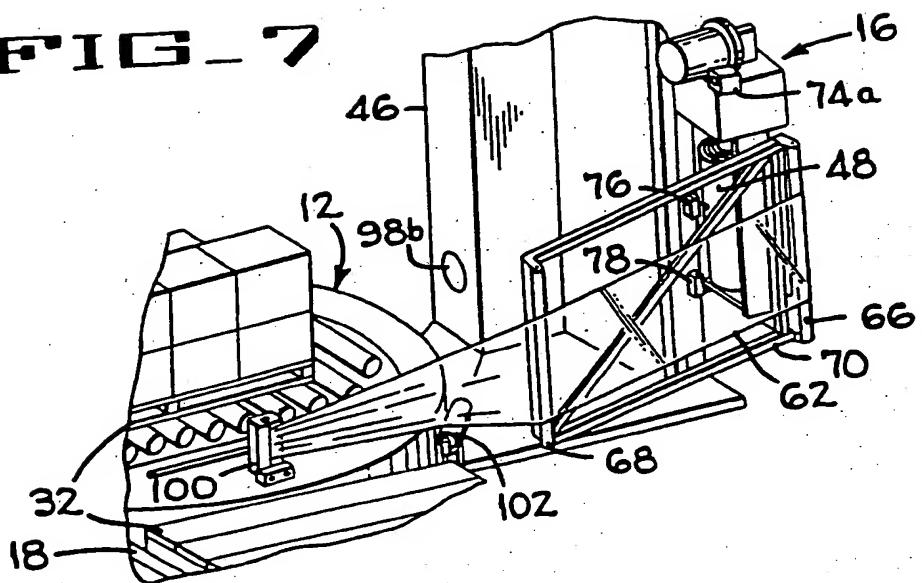
**FIG. 2F**



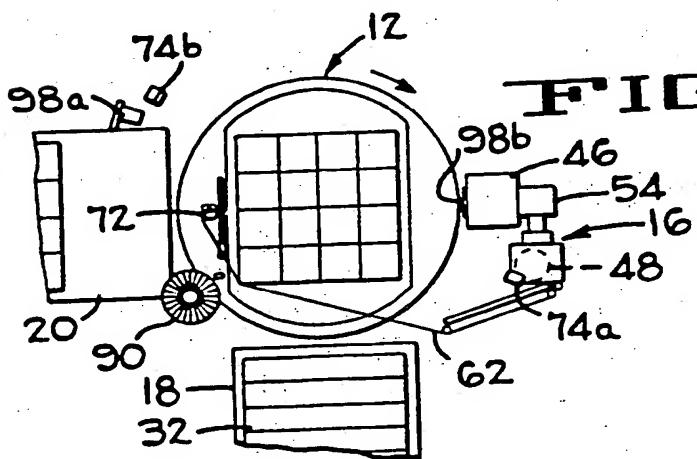
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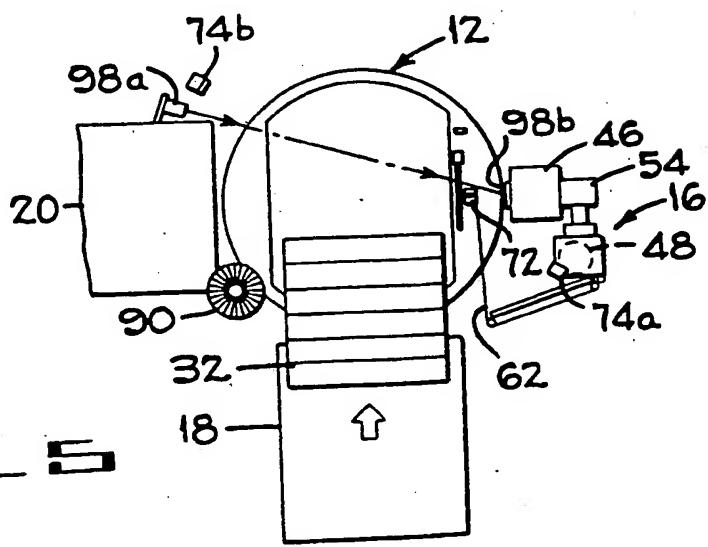
## **FIG-7**



**FIG. 4**



## **FIG.-5**



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LOAD UNITIZER

This invention discloses and concerns an article stack unitizer having the capability of receiving discrete articles from a source of supply, transferring those articles to an article stacking station where the articles may be stacked on a "pull sheet," a base sheet, in a low sided box, on a pallet, or directly on the surface of the article stacking station and then providing a film wrap around the stacked articles in order to "build" a stable unitized or palletized load. For readability of this specification the term "palletizer" and its derivatives such as "palletizing", "palletized", "pallet" and the like is used to mean any type of stacked article unitizing where the articles are stacked on a pallet, a sheet surface or on the surface of the unitizer's turntable where no bottom sheet or pallet is used.

In prior art palletizing systems it has been normal practice to feed or serve a product to a pallet supported on a work stand. Each article, or group of articles making up a palletized load, would be placed on the pallet in a location to maximize the number of elements that can be stacked on a pallet while also attempting to interlock the elements in order to provide some stability to the load once it has been fully accumulated on the pallet.

After stacking articles or elements to form a full pallet the full pallet is then removed from the work stand and delivered to a wrapping station having a strapping

machine, a shrink wrapping machine, a stretch wrapper or other type of wrapping equipment. At this wrapping station the palletized load is wrapped or banded in order to provide continuity and stability to the load.

According to the present invention, there is provided a method of producing a unitized stack of articles, wherein:-

the articles are stacked upon a turntable and a web of wrapping material supplied from wrapping material serving means is wrapped around the stacked articles by rotation of the turntable with respect to the serving means.

The present invention also provides apparatus for producing a unitized stack of articles, comprising:-

a turntable for supporting said stack of articles whilst they are stacked and wrapped;

a palletizer for stacking said articles on said turntable; and

wrapping material serving means for delivering a web of wrapping material to the turntable.

The apparatus of the present invention may comprise an advanced robotic palletizer or stack unitizer, which in itself is an advanced palletizing unit that incorporates a programmable material handling element that will typically pick up an article or articles to be stacked from a supply conveyor or location and then position these articles on a pallet or on previously palletized articles. The programmed material handling element may stack the articles

in a preassigned location on the pallet that will provide a degree of load stabilization by the interlocking, or overlapping or cross stacking of the articles on the pallet. Such interlocking is not a true interlocking of stacked articles but is more of an overlapping of articles stacked on one another so that straight columns are not formed during stacking. In many prior art systems the palletized loads are not significantly stable before wrapping.

Integral with the advanced robotic palletizer of the preferred embodiment of the present invention is equipment that allows the robotic palletizer to wrap the stacked pallet in a film of plastic material that assists in stabilizing the palletized load during its formation.

The robotic palletizer may be provided with sensors or alternatively a preprogrammed sequence of operations, that direct the palletizer to initiate wrapping of the load at the most favourable intermediate vertical stages prior to the final stack height and then complete wrapping of the load.

In the preferred embodiment a film supply source is supported on the palletizer equipment and can move vertically as film is being unwound, being guided by various guide rollers, to wrap the accumulated articles on the pallet as the pallet is being "built".

Using this embodiment, column stacks of articles such as boxes or cartons can be made, since the pallet load is wrapped at intervals during the building of the palletized

load thus increasing the stack integrity. By allowing column stacks, rather than the interlocked stacks of previously known palletizers, the inherent strength of the boxes or cartons can be utilized in order to create strong unified, unitized stacks of products. This of course allows greater stack height, heavier loads, more dense loading on a pallet resulting in better pallet utilization and the advantages attendant thereto such as decreased shipping costs, and of utmost importance a decrease in damage to the carton contents resulting from collapse of the boxes on the lower levels of the stack.

Embodiments of the invention are described below by way of example with reference to the drawings, wherein:-

Figure 1 is a simplified isometric presentation of an embodiment of the invention;

Figure 2 is a plan view of Figure 1;

Figures 2A through 2F are plan views of alternative infeed and output conveyor arrangements;

Figure 3 is a schematic of the film pass line through the apparatus of Figure 1;

Figure 4 is a pictorial plan view of Figure 1;

Figure 5 is a pictorial plan view of Figure 1;

Figure 6 is a chart showing timing elements on a revolution of the turntable of Figure 1, and

Figure 7 is an alternative embodiment of a portion of the invention.

The Figure 1 presentation shows the general arrangement

of the palletizer and this figure will be described first. Like reference characters in the other views represent the same parts as in this view.

The palletizer, generally 10, is made up of three major components. The turntable, generally 12 which may be rotatable to any desired speed, the robotic palletizer generally 14 and the film elevator generally 16 are the major components. Several satellite components of a preferred embodiment of the palletizer are also shown. A pallet infeed or supply conveyor 18 is located adjacent the turntable and will serve a pallet to the turntable on demand. Once a pallet is fully loaded and wrapped the pallet will be shuttled to the pallet discharge conveyor 20. Product infeed is directed to the palletizer by means of the product conveyor 22.

As stated earlier in this specification the apparatus is contemplated as being able to stack and wrap articles on various surfaces such as "pull sheets", base sheets, low sided boxes and the like or even directly on the surface of the turntable. A preferred embodiment may include stacking on a conventional pallet. However equally good utility can be realized when using the apparatus to stack and wrap on alternative surfaces such as the surface of the turntable.

In the event that a conventional pallet is not being used it would be appropriate to eliminate, if so desired, the pallet supply conveyor and possibly the output conveyor.

As shown in Figure 1, a metering infeed conveyor 24

will be the first element of the palletizer operation encountered by an article or package such as 25 to be palletized. The package, box, carton or other article 25 could be of any configuration that is stacked for shipment or storage on a pallet, pull sheet or the like or the surface of the turntable. Typically the article 25 could be a box, can, carton, open top carton, tray of material, nested elements such as buckets, or even sacks or bags of material, containers or pouches. The term "article" is not intended to be limiting and is used as a generic for stackable materials being stacked together.

The metering infeed conveyor 24 may be equipped with a rough surface top belt to provide separation between articles as it delivers the articles to the product conveyor 22. Articles may be aligned to one side of the metering infeed conveyor by an adjustable rail guide (not shown). The product conveyor, also known as a station conveyor or input station means, is a live roller assembly in a preferred embodiment. Two or more photoeye sets are used on this conveyor. Each set 26 a and b and 28 a and b consists of a source/receiver component, the "a" components, and a reflector, the "b" components, which reflect the light from the source back to the receivers. This is conventional technology. Various types of sensors which may or may not require reflectors may be used in place of the photoeye sets set out herein. Throughout this specification photoeyes and reflectors are discussed however

these are simply one means of sensing contemplated by the inventor. The first photoeye set 26 is used to count articles entering the station conveyor. The second photoeye set is used to detect when the last of a set 34 of articles has accumulated on the station conveyor.

The "set of articles" 34 is that quantity of articles that should be accumulated before they are picked up by the robotic palletizer and transferred to the turntable 12. A set of articles 34 would be, for instance, the four boxes in contact with each other on the station conveyor.

A stop, which stops the articles on the conveyor is shown as 30. Other stops, not shown, may be positioned below the roller bed and activated as necessary to interpose gaps between the boxes being accumulated.

Once a set of articles 34 is accumulated, the robotic palletizer can transfer them to an awaiting pallet on the turntable 12. Any incoming upstream articles not necessary to complete a set will be stopped until the full set of articles has been picked up by the robotic palletizer and clears the station conveyor.

In a normal cycle a pallet 32, or the equivalent of a pallet such as a skid, "pull sheet", base sheet, platform, container means or the like, will be in position on the turntable. Obviously, in the event that a unitized load is to be built without a pallet or base sheet no pallet or the like need be in position. The set of articles 34 will now be lifted by the grasping means 36 which may have any one of

numerous types of "hands". Figure 1 shows the use of "palms", two of which, an inboard palm and an outboard palm, have been marked as 38. One of the palms is stationary and the other of the palms may be operated by an air cylinder (or other closing or actuating means) to move toward the set of articles 34 and clamp or grasp them between the palms. "Hand" type is determined by application and a myriad of hand types, including multiple palms, bottom support hands, vacuum, and top and bottom clamping, and the like, are known in the industry.

The structure of the grasping means 36 is carried through cam rollers to a boom 40. The hand may also be articulated or movable on its support on an axis perpendicular to the boom axis. The rollers of the grasping means engage guide rails 42 and 44 so that the grasping means 36 can traverse laterally from a location above the station conveyor 22 to a specific discharge location on the pallet on the turntable 12.

The boom 40 is slidably mounted on the mast 46 so that the boom can move vertically on the mast. In a typical "pick-and-place" operation the two axes provided by the mast and the boom will be sufficient to transfer articles or sets of articles from the station conveyor 22 to the pallet 32. The operation proceeds as follows: The grasping means 36, poised above the set of articles 34, is lowered, the hand clamps causing the palms to grip the set of articles, the boom raises on the mast, the grasping means 36 moves along

the boom 40, the boom 40 moves down the mast 46, and the hand opens depositing the set of articles 34 on the pallet in a predetermined location. To return to start the palms of the grasping means 36 are opened away from each other, the boom raises away from the pallet. the grasping means 36 moves back along the boom 40, the boom moves down the mast 46 and the grasping means is ready to grasp another set of articles. The palletizer is programmed to initiate movement, travel, change speed and find the proper position for palletizing the sets of articles in the predetermined desired stacking pattern.

After a palletized load has been partially "built", that is stacked in a predetermined pattern, the partially palletized load can be partially wrapped with film to add stability to the partially palletized load. The stacking pattern has traditionally been one that seeks to maximize the number of articles on the host pallet while interlocking the articles to help in palletized load stability and integrity. Oftentimes this requires that articles in a layer be aligned along one axis of the pallet. On the next layer the articles will be aligned along the other axis so that a certain amount of interlocking will take place. Seldom heretofore have boxes been stacked in vertical columns. Although the column strength is much better when articles such as boxes are stacked directly on top of each other as the boxes can be arranged so that their strongest parts, the corners, are stacked on top of each other from

box to box, the resulting tall column is very unstable and all but unusable in practice. The instant invention however does provide for effective column stacking and thus the apparatus of this invention can provide a much more stable and strong palletized load than has been possible in the past.

Once a partial load has been stacked on a pallet or the like, the wrapping operation will be initiated by the controller for the palletizer.

In a preferred embodiment a partial pallet load could be as few as two layers of articles. (Wrapping can be done after only a single layer of articles has been stacked on the pallet however this would not be a preferred embodiment.)

A plastics film that has high hysteresis after initial stretching, conventionally known as "stretch wrap" film, is the preferred wrapping material used by this equipment.

The wrapping material can be other types of film such as shrink wrap film, polymer film, perforated film, netting, coated or uncoated paper, ribbon, protective covers such as bubble pack, and other covering materials or the like. For convenience the wrapping material will be referred to as "film" in the disclosure.

The film, shown as a roll of film 48 is carried by the film elevator 16 (film unwind or serving unit) which is slideably mounted on a vertical track 50. A chain hoist is used to raise the film elevator. The chain 52 is attached

to the film elevator at both ends and passes around a drive motor (not shown) which is inside the vertical track support 54 for convenience. The film is threaded (see Figure 3) from the film roll 48 into a pre-stretch head 16, in which it passes around a first main drive roller 56, then around a second main drive roller 58. These two rollers induce a significant amount of tension on the film (called "pre-stretch"). The film then passes dancer roller 60 which is movably mounted to compensate for variations in the speed of drive of the main drive rollers 56 and 58 with respect to the film consumption rate. The film 62, after leaving the pre-stretch head 16, then passes over a guide roller 64, a first guide arm roller 66 and a second guide arm roller 68, both of which are mounted on a film guide arm 70. The film then is directed to a wrapping material or film clamp 72 which is mounted on the turntable 12.

The film guide arm 70 serves to direct the film around the mast 46 and to the film clamp 72 mounted on the turntable 12. In a preferred embodiment the film guide arm is held in a fixed position but may be pivotally mounted for swinging movement about its attachment point to the film elevator 16. If the guide arm is pivotally mounted resistance to swinging by means of a spring, air cylinder or like may be advantageous in maintaining film tension to the film clamp 72.

In an alternative embodiment a pivotally mounted guide

arm, being actuated by a motor of any type, by gravity or by springs, would be programmed to be biased from a first position to a second position to maintain tension in the film specifically when the film would normally have to be stretched and then released. By providing a pivotally mounted guide arm the amount of stretching and subsequent relaxation of the film can be controlled and minimized. Returning again to a description of the embodiment, the height of the guide arm and the length of the guide arm rollers is sufficient to accept the width of film being let off the film pre-stretch head. Typically film can be about twenty inches (508 mm) wide, however wrap means wider or more narrow than twenty inches is also commonly used. It would not be unusual to use film that is as wide as (or wider than) forty inches (1016 mm) or as narrow (or more narrow than) ten inches (254 mm).

The plan views presented in Figures 2, 3 and 4 have been presented to assist in providing an understanding of the apparatus.

In Figure 2, for instance, the turntable 12 is shown with at least a partial load of articles, for example boxes, already in place. The mast 46, boom 40, grasping means 36, product conveyor 22 (the rollers have been left out of these views for simplicity), and the film elevator, 16, are each shown pictorially. Also the pallet infeed conveyor 18 and the pallet discharge conveyor 20, are shown carrying an empty pallet 32 and a fully palletized load 33 respectively.

The significant items that are more easily seen and understood in Figure 2 than in Figure 1 include the "line of sight" paths of a third photoeye set 74a and b, a pallet sensing photoeye set 98a and b, and a wrapping material pat-down brush 90.

The pallet sensing photoeye set 98 is a conventional photoeye having an integral beam emitter and receiver represented as 98a and a reflector represented as 98b which will reflect the beam back to the receiver unless a pallet (or other item) blocks the light beam. When the beam is blocked the palletizer controller knows that a pallet is in position and the controller can initiate box stacking on the pallet. When a pull sheet or base sheet is the surface on which boxes will be stacked the photoeye set 98 may be replaced with a reflective photoeye sensing system or a manual or automatic switch or the like providing a signal to the controller that it can begin stacking boxes. It should also be realized that boxes can be stacked directly on the turntable surface for transport by a "palm" truck or the like if so desired.

A third photoeye set 74a and b can be seen in this Figure as well. This photoeye set senses the top of a layer of boxes. This input is used by the controller to control the vertical upward limit of the film elevator 16.

Figures 2 and 3 also show the film path from the film elevator 16 to the film clamp 72. In Figure 3 the roll of film 48, from which film 62 is unwound is shown in a

pictorial plan view. The film 62 is threaded around first and second main drive rolls 56 and 58, which are driven at a speed differential in a preferred embodiment in order to prestretch the film, then around a dancer roller 60 and a guide roller 64. The film then passes over first and second guide arm rollers 66 and 68 and then to the film clamp 72 which is shown in the "home" position (for the preferred embodiment) in all the Figures except Figures 4 and 5.

In Figures 4 and 5 intermediate stages of a typical stacking and wrapping cycle are shown. In Figure 4 a wrap cycle has been initiated and the turntable has rotated clockwise 90°, for example, on a first wrap cycle. The film 62 is held fast in the film clamp 72 and the film is seen to be in contact with the corner of the stack of boxes on the turntable. Upon the turntable reaching the home position one wrap of the stack of boxes will have been made. The cycle will continue as explained in this disclosure.

In Figure 5 the loading or positioning of an empty pallet is shown. Since the film clamp 72 will normally be upstanding at the completion of the wrapping of a full load and will be in the "home" position shown in Figure 2 it is necessary to get the film clamp (and the film 62) out of the path of the pallet 32 as it is being loaded. One way to do this is to rotate the turntable counterclockwise 90° as shown in this figure. It should be noticed that film 62 is taut when the film clamp is in the position shown in the

Figure. The pallet sensing photoeye 98a will have its beam broken when the pallet 32 moves further into position on the turntable.

A wrapping cycle of a preferred embodiment palletizer represented by Figure 1 will be initiated by the palletizer controller when a signal is received by the palletizer that the height of boxes desired for the first wrap cycle has been achieved. Good machine performance and stack integrity is achieved if the first wrap cycle is performed after two layers of boxes have been positioned.

In the first wrap cycle the film is held clamped in the film clamp 72. The grasping means 36 has been cycled away from the partially stacked pallet and continues to cycle to pick up the next set of boxes while the first wrap cycle is being performed. The turntable 12 is rotated clockwise from a home position (from above), generally the zero and three hundred sixty degree position in this preferred embodiment, causing film to be pulled off the roll of film 48. Close in timing to the initiation of turntable rotation, that is either before, after, or simultaneously therewith, the film elevator 16 has been signalled by the palletizer controller to move vertically upward on the vertical track 50. Such upward movement of the film elevator will cause a lower film elevator travel limit switch 78 to open. Upward movement of the film elevator causes the film to be spiralled up the stack of boxes on the pallet as the turntable continues its rotation. The film

is now being wrapped around the stack while still being held by the film clamp 72.

This first wrap cycle will continue until the palletizer senses that the top of the top layer of boxes has been reached. Generally, the first wrap cycle is accomplished in one 360° rotation of the turntable, however more than one rotation may be beneficial in some applications. The signal, signifying that the top layer of boxes has been reached, will come from photoeye three 74a which sends a beam of light to a reflector 74b mounted on a vertical support or reflector pole. The reflector 74b is a continuous reflector of significant length mounted on the reflector pole whose length is sufficient to accommodate boxes of different heights. When the photoeye sensor 72a senses the top of the boxes it will signal the palletizer controller to signal the film elevator drive to stop elevating the film elevator. At this point the turntable will continue rotating until it has returned to its home position. The film clamp 72 maintains the film in its clamped position.

Although the film elevator will normally be set to stop its upward travel at a point where the film does not go above the top of the boxes on the pallet it may be advantageous in some cases to allow the film elevator to go higher. If, for instance, the film elevator goes to a point such that the film is two inches (51mm) higher than the top surface of the boxes the film will be stretched to

be drawn inboard of the outer edges of the boxes. This may be advantageous, in stabilizing the stack, if the following set of boxes is then placed on this inwardly directed portion of the film.

Upon the turntable returning to the home position the stacking unit will commence stacking more layers of boxes on the pallet. It will stack, for instance, another two layers of product and signal the commencement of the wrapping cycle. The second and subsequent wrapping cycles will be, in a preferred embodiment, repeats of the first wrapping cycle until the full height of the palletized load is achieved - full height being the number of layers of boxes that have been preprogrammed into the palletizer controller.

When a fully stacked load has been accumulated on the turntable the top of the boxes of the top layer are sensed by the third photoeye set 74 and the film elevator will stop elevating the film roll to prevent the film from going off the top of the stack. This is the same as the sensing of the prior spiral wrap cycles.

As earlier pointed out in discussing the completion of the first wrap cycle it is possible to extend the film somewhat higher than the top of the layer of boxes in order to provide some further unitizing assistance to the full load of stacked articles. The film elevator can be programmed to go slightly higher than the top of the boxes either immediately or internally to possible multiple wraps

at the top of the stack.

Once the spiral wrap has been applied to the fully palletized load a unifying wrapping of the palletized load would be desirable to further unitize, strengthen and build integration into the palletized load. While the spiral wrapping accomplished in the first and several subsequent wrapping cycles serves to unify and help support the load as it is being stacked, allowing by the way, the building of a load of column stacked boxes among other advantages, it may or may not be as complete a wrapping job as desirable for insuring integration of the palletized load.

It may be desirable, as an alternative, to do all the wrapping of the pallet load as the stack is being formed. In this case instead of just spiral wrapping on the way up the controller would direct the unwrapping head to stay at a horizontal position while the turntable made a single or a number of revolutions to wrap the stack at that level. This could be done at various heights on the stack as it is being built. This would lessen the time to wrap after the load has been stacked as some of this wrapping could be internal to the "picking" of the stacker.

Further wrapping, of the preferred embodiment style of the invention, and if desired, would be completed as follows. With the film elevator high on the vertical track 50 and signalled not to go any higher by the photoeye set 74, the palletizer controller signals the turntable to make at least one full revolution, three revolutions works well,

while the film elevator is held in its position relative to the top of the palletized load. After the desired number of revolutions have applied a "top wrap", and if desired, the film elevator is signalled to let the film elevator travel down the vertical track 50 at a controlled rate while the palletized load continues to rotate. The film elevator may be directed to hold its horizontal position or to decline at a slow rate to apply more film at designated heights of the palletized load or it may continue to travel downwardly thus spiral wrapping the palletized load during its travel.

A sensor or intermediate switch 76, typically a micro switch or the like, will signal the palletizer controller when the lower portion of the film elevator is just above the top of the film clamp 72 - which at this point in the cycle is still clamped to the leading edge of the film.

When this intermediate switch 76 is "made" the palletizer controller signals the film clamp to retract and let the leading edge of the film hang free. With the film clamp retracted to a position typically below the bottom of the first layer of boxes the film elevator generally 16 can continue its downward travel and wrap the bottom portion of the palletized load with several layers of film through several rotations of the turntable.

A variation of the first spiral wrap cycle or the first or second rotation of the full top wrap cycle would be to allow the film wrapper to position a portion of the film, on

the order of several inches, more or less, depending on the stretch qualities of the stretch wrap film above the top of the top edge of the top layer of boxes. This could create a degree of improved integrity in some types of stacked products.

It would be possible to use this technique at the intermediate stages of the spiral wrapping operation however such technique is not the most preferred embodiment.

In some situations it is desirable to have the film extend over the supporting pallet, low box or the like on which the articles are stacked. This provides continuity between the supporting pallet and the articles so that the articles and the pallet are somewhat packaged together. This is not always necessary or desirable.

Returning to the completion of the cycle, the leading edge of the film has been rapidly covered, at least partially by the film being wrapped on the palletized load as the film elevator goes to the lower section of the load. Although the leading edge of film is rapidly covered through rapid rotation of the turntable, it has been found that a stream of air directed at the loose leading edge of the film is advantageous in holding the leading edge of the film against the load until the film can be overlayed with subsequent wraps of film. An air nozzle 80, which receives air from an air supply (not shown) provided to the turntable, is mounted on the turntable to accomplish this function.

On the final revolution of the turntable after the desired number of wraps or revolutions have been made it is necessary to position the film in the film clamp in preparation for the next palletizing operation. This is done in the final one hundred and eighty degrees of revolution of the turntable. The film clamps are in a retracted deployment at the start of the clamping cycle. After the turntable has rotated one hundred and eighty degrees on its final rotation a signal is sent to the palletizer controller to deploy the trailing element 84 of the film clamp. It should be pointed out that the film clamp 72 is made up of two major clamping elements. These are the leading element 82 and the trailing element 84. The leading element is a structural member having a grip enhancing surface such as a rubber coating along its film engaging surface. The trailing element 84 also is a structural member with a grip enhancing surface. When film is positioned between the leading and trailing elements it is held fast until the film clamp is opened (just before the film elevator 16 interfaces with the upright film clamp 72).

Once the trailing element 84 has been deployed into an upstanding position - the leading element is still in a retracted or generally horizontal position - the continued rotation of the turntable will cause the trailing element 84 to contact the film between the palletized load and the film guide arm 70. The turntable continues its rotation and during this continued rotation the leading element of the

film clamp is deployed into a position to clamp the film between the leading and trailing elements of the film clamp.

At this point the film is clamped in the film clamp but is still attached in a continuous sheet to the fully wrapped palletized load. To sever the film it has been found that a heated rod pivoted across the film path will cleanly cut the film. Such a heated rod film terminator or cutter is shown as 86 in a retracted position on the turntable. The heated rod is carried on a support that is pivotally mounted at one end and is further actuatable by an air cylinder (not shown).

Once the film is severed by the heated rod or other wrapping material cutting element such as a hot wire, a knife, or the like, the palletized load is completed and it can be moved off the turntable.

In a preferred embodiment the turntable has a powered roller deck surface 88 that can discharge the palletized load to a pallet discharge conveyor generally 20.

However the palletized load is removed from the turntable it has been found that in some applications it is desirable to "pat down" or smooth over the trailing end of the film to remove trapped air for better tail adhesion to the load. This trailing film end is normally stuck to the film on the palletized load since it "springs back" somewhat after being cut by the heated knife 86. Nevertheless an optional step in the method of palletizing discussed here is to "pat down" the end of the film through the use of a

securing means 90. The securing means shown in Figure 1 is a brush 92 supported on a stanchion 94 and having a drive means 96 for rotating the brush 92 as the pallet moves from the turntable to the pallet discharge conveyor 20. The brush may be spring loaded to be urged against the palletized load in the proximity of the trailing end of the film to thereby pat down the trailing end to the film below it on the pallet. Alternative brush positions 92 are shown in full and dotted lines in Figure 2. The securing means can be any of several types of devices such as a soft surfaced or hard surfaced roller, a blast of air directed to the film trailing end, a stationary ramp that applies pressure to the film tail as it is delivered to the pallet discharge conveyor, or the like.

In situations such as shown by Figure 5 where the film 62 will "go slack" as the turntable is rotated counterclockwise and then get taut again as the film clamp 72 gets to the 90° position shown, it has been found to be advantageous to control the amount of prestretch exerted on the film by the prestretch rolls, these being the first 56 and second 58 main drive rolls, so that film is not payed out unnecessarily.

Figure 6 is a chart that shows how the rolls 56 and 58 are turned off and on to assure that excess film is not fed. It should be noted that the drive rolls 56 and 58 are turned "on", stripping film from the film roll 48 in response to dancer roller 60, which is free to move inboard as shown by

the arrow in Figure 3, when more film is needed. This is contemporary film unwind practice. But when using prestretch film the film will, after being initially prestretched between rollers 56 and 58, "recover" causing dancer roller 60 to be pulled inboard and initiate driving feed by the rollers 56 and 58. This will happen to a controlled degree whenever the film is not being wrapped on the boxes - typically when the turntable is in the home position.

The Figure 6 chart shows how the prestretch unit is shut off or turned on on the final revolution of the wrap cycle and the reversing of the turntable to allow the pallet to be loaded. The controller is given signals from limit switches that are placed to pick up turntable position.

Starting at point A and progressing to B (arrowheads indicate direction of turntable travel) the film prestretch unit is "on", that is it is operative to feed film during this final revolution of the load and turntable. At point B approximately 330° of rotation the prestretch unit is turned off ceasing the possibility of feeding of film (B, to C). From C, to D the turntable is moving counterclockwise to approximately 270° as shown in Figure 5 - prestretch unit is off. After the pallet is loaded the turntable rotates clockwise and at approximately 330° (D, to E, prestretch unit is off) the prestretch unit is turned on for the duration of the revolution (E, to F).

Figures 2A through 2F have been provided to show

layouts of ancillary services to the palletizer. The principles of operation of these alternative layouts will be the same as the embodiment shown in Figure 1 for the most part.

Figure 2A is simply the reverse of the Figure 1, 2 structure such that product infeed is on the left side of the turntable (reference point is from mast in direction of boom).

Figure 2B has a pallet infeed conveyor 104 entering the turntable from the right of the turntable. In this embodiment the product conveyor 22 may be elevated to allow pallets to be served underneath it. In this layout the turntable may have to be rotated counterclockwise such that the film clamp 72 will not interfere with the loaded pallet being unloaded from the turntable to the pallet discharge conveyor 20.

Figure 2C is simply the reverse of the Figure 2B layout.

Figure 2D is similar to Figure 2 except that the position of the pallet infeed or supply conveyor 18 has taken the place of the pallet discharge conveyor 20 and vice-versa.

Figure 2E is simply the reverse of the Figure 2D layout.

Figure 2F is a palletizer with no pallet infeed or discharge conveyor. The palletizer turntable 12 will be serviced by transport means such as a forklift truck or a

pull sheet handling vehicle.

Figure 7 shows an alternative embodiment of the invention specifically directed to the use of a short film clamp 100. All other aspects of this embodiment are the same as shown in Figure 1 with the exception of the short film clamp 100, the added film roping roller 102 and the repositioning of the lower switch 78 to a position lower on its support than the position of the switch in the Figure 1 embodiment.

In this embodiment the film clamp 100 is shorter than the width of the film 62. The film 62 is thus "roped down" or bunched as shown to fit into the jaws of the film clamp. The film elevator 16 has dropped so low on the vertical track 50, due to the low position of the limit switch 78, that the film would foul on the upper surface of the turntable. The roping roller 102 guides the film above the turntable surface and as it does it tends to "rope down" the film. The advantage of the shorter film clamp 100 is that on the initial wraps of the lower levels of boxes the film elevator does not have to be lifted as high to clear the short film clamp as it would if there were a taller film clamp (Figure 1) being used. This allows wrapping more of the lower level of the stacked boxes which may be advantageous for some loads.

This disclosure has attempted to set forth a description of apparatus that can stack and unitize a collection of articles into a unified package. Although

several modes of carrying out the invention, including a best mode known to the inventors, have been disclosed it is contemplated that nuances of design and engineering expediencies may be utilized in the design of a unitizing wrapper. Such nuances and expediencies are contemplated by the inventors and are sought to be covered by the following claims.

## CLAIMS

1. Apparatus for producing a unitized stack of articles, comprising:
  - a turntable for supporting said stack of articles whilst they are stacked and wrapped,
  - a palletizer for stacking said articles on said turntable, and
  - wrapping material serving means for delivering a web of wrapping material to the turntable.
2. Apparatus as claimed in claim 1, further comprising:
  - a controller for initiating operation of the turntable,
  - palletizer, and
  - wrapping material serving means.
3. Apparatus as claimed in claim 1 or 2 wherein the palletizer includes an upstanding mast, a transverse boom mounted for vertical movement on the mast and a grasping means carried mounted for transverse movement on the boom; such that the grasping means is movable in use between a position above the turntable and a position above an article pick-up area not occupied by the turntable.
4. Apparatus as claimed in any preceding claim, wherein the wrapping material serving means includes a first

and a second main drive roll for unwinding and pre-stretching wrapping material delivered from the serving means.

5. Apparatus as claimed in any preceding claim wherein the wrapping material serving means includes a guide arm for delivering wrapping material to the turntable.

6. Apparatus as claimed in any preceding claim wherein the wrapping material serving means is vertically movable with respect to the turntable.

7. Apparatus as claimed in any preceding claim, including a cutting element for severing the wrapping material delivered by the serving means to a completed unitized stack.

8. Apparatus as claimed in claim 7 wherein the cutting element is mounted upon the turntable.

9. Apparatus as claimed in any preceding claim, wherein the turntable is provided with a wrapping material clamp for holding the leading end of the wrapping material web delivered to the turntable.

10. Apparatus as claimed in claim 9 wherein the leading end of the wrapping material is released from the

clamp during wrapping of the stack, and an air nozzle is provided, positioned to direct an air blast against said end to hold it against the stack, or a roller or other means are provided to hold said end against the stack.

11. Apparatus as claimed in any preceding claim, including a wrapping material pat-down brush urgeable against a trailing end of the wrapping material.

12. Apparatus as claimed in any preceding claim, including a pallet delivery conveyor and a completed unitized load receiving conveyor.

13. Apparatus as claimed in claim 9 when dependent upon claim 6 wherein a lower edge of the wrapping material web is disposed below a stack supporting surface of the turntable when the serving means is in its lowermost position, and a guide is provided adjacent to the turntable for directing said lower edge to the wrapping material clamp, the clamp being shorter in transverse extent than the web, such that the wrapping material is thereby bunched or roped down.

14. A method of producing a unitized stack of articles, wherein:-  
the articles are stacked upon a turntable and a web of wrapping material supplied from wrapping material

serving means is wrapped around the stacked articles by rotation of the turntable with respect to the serving means.

15. A method as claimed in claim 14 wherein the articles are stacked upon the turntable in successive layers and after the addition of one layer the turntable is lowered for receipt of the next layer.

16. A method as claimed in claim 14 or 15 wherein the stack is formed in a number of vertical stages, and at each stage the turntable is rotated to wrap articles added to the stack in that stage.

17. A method as claimed in claim 16, wherein each stage comprises the addition of one or more horizontal layers of articles to the stack.

18. A method as claimed in any of claims 14-17 in which the wrapping material serving means is movable vertically with respect to the turntable during rotation of the turntable, such that the stack is helically wrapped in the wrapping material.

19. A method as claimed in any of claims 14-18 wherein a leading end of the web is initially held in a clamp provided on the turntable and, after rotation of the

turntable through at least one revolution, is then released from the clamp.

20. A method as claimed in claim 19 wherein the leading end of the web is subsequently released and is held against the stack by hold-down means until it is covered by subsequently applied turns of the web.

21. A method as claimed in any of claims 14-20 wherein, after completion of the stack, a number of turns of wrapping material are applied to the top of the stack by rotation of the turntable with respect to the serving means.

22. A method as claimed in claim 18 or any of claims 19-21 when dependent upon claim 18, wherein a final outer helically wrapped layer of the web is applied to the completed stack.

23. A method as claimed in claim 19 or any of claims 20-22 when dependent upon claim 19, wherein following wrapping of the completed stack, the web extending between the wrapping material serving means and the stack is engaged by the clamp and is severed at a location between the clamp and the stack.

24. A method as claimed in any of claims 14-23 wherein, during its formation, the stack is formed supported

directly upon a surface of the turntable or upon a pallet, pull sheet, base sheet or low-sided box supported by the turntable.

25. A method as claimed in claim 24 wherein the stack is supported upon a pallet and a lower turn of the web is applied to the stack such that an edge of the lower turn overlaps the pallet.

26. A method as claimed in claim 16 or any of claims 17-26 when dependent upon claim 16, wherein at each said stage an uppermost turn of the web is applied to the stack, such that the upper edge of each uppermost turn extends beyond the upper edge of the stack.

27. A method as claimed in any of claims 14-26 wherein the web is pre-stretched prior to wrapping of the stack.

28. Apparatus for producing a unitized stack of articles substantially as described with reference to or as shown in the drawings.

29. A method of producing a unitized stack of articles substantially as described with reference to the drawings.